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Review Article

BrainGate - A Computer Innovation for Patients with Paralysis

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Abstract

Brain gate is an electrode chip that's implemented in the cortex of the brain. It is a system developed by cyberkinetics, a biotech company in the year 2003 in connection with neuroscience department at Brown University. It helps to exchange the electrical signals between brain and the electrical gadgets. The principle behind this brain implant system is with normal brain functions, brain signals are been generated, but they can't be sent to arms, hands or legs, these signals are understood and translated to cursor movements, which helps the individual to regulate the computer by his or her thoughts. Special software carries all the signaling processes.

Keywords: Brain gate; Electoral signals; Cursor movements

Introduction

Brain gate is an implant system that is developed to assist the people who have limbs loss or lose their bodily functions like patients with spinal cord injury. It is a mind-to-movement system that permits a paralyzed person to regulate a computer using his thoughts [1].

Brain Gate is to help those who have limbs loss, or other bodily functions, such as spinal cord injury to work various gadgets like TV, computer, lights, fan etc. It interprets brain activity within the patient and translates the user's thought into computer commands. These computer commands are used to move a cursor on a screen or control a robotic arm.

Types of Brain Computer Interface (BCI)

BCI stands for Brain Computer Interface. It usually connects the nervous system with a computer system. A BCI, also known as direct neural interface or brain machine interface, it is a direct pathway of communication between animal or human brain and an external device.

- BCI is classified as the following on the basis of pathway of communication:
  - One way BCI
    Computers accept commands either from the brain or send signals to the brain, but not both ways. That is, information passes from brain to computer or computer to brain in a one way pathway [2].
  - Two way BCI
    In this the exchange of data occurs in both directions, between brain and external devices.

Development of Brain gate

After 10 years of study and research, Brain gate was developed by Cyber kinetics, a bio-tech company in Massachusetts laid down by a Neuroscientist, Nicholas Halsopulas in Chicago University in 2003 in association with the Neuroscience Department at Brown Uni-

versity. The Director of the brain science program, Dr. John Donaghue at Brown University made Brain gate possible for the patient's use.

Research on BrainGate in animals

At first, BCI were implanted in rats. Signals from the cerebral cortex of the rat were recorded to operate the BCI to perform the movement. Experiment on a monkey was done by Researchers at the Pittsburgh University and found that the monkey can eat itself with the assistance of a robotic arm by using brain signals. It had been a success- only using its mind monkey was ready to control a computer cursor on the monitor through Brain gate (3). Human trails started after found no complications with animal trials.

Human Clinical Trials

In humans the clinical test was first done in Mathew Nagle in the year 2004, he was the first person to use the BCI to replace functionality which was lost because of paralysis. He was paralyzed from neck to down. Gerhard Friehs, a Neurosurgeon implanted the Brain gate chip in Nagle's brain. After this, he was up to control a computer mouse cursor and with its help he was able to operate T.V, check e-mails etc [4].

Figure 1: Picture of Mathew Nagle performs functions with Brain gate.

Cathy Hutchinson, a lady who has suffered a stroke which made her mentally sharp, but paralyzed and unable to speak. She was able to pick up and drink coffee from a bottle with the help of robotic arm. It was the first time in 15 years of stroke she was able to drink independently. This took place in a specialized residence at The Boston Home in Dorchester, Massachusetts, where Ms. Hutchinson resided.

Figure 2: Picture of Cathy Hutchinson having coffee with Brain gate.

Principle of operation

The principle behind the Brain Gate System is that with normal brain function, brain signals are been generated, but they cannot be sent to arms, hands or legs, these signals are understood and translated to cursor movements, which helps the individual to control the computer by his or her thoughts. It helps the user in providing an alternative Brain Gate pathway, making them just like an individual who have the ability to move their hands to use a computer mouse [5].

Brain gate Components

The Neuro chip

It is a 4-millimeter square silicon chip, studded with 100 hair-thin microelectrodes is embedded in the primary motor cortex the region in the brain, which is responsible for controlling movement [6].

The connector

According to the user's thought to move cursor up or down, the cortical neurons pass in different direction, the signals are transmitted through the pedestal plug which is attached to the skull.

The converter

The signal travels to a shoebox -sized amplifier that is mounted on the user's wheelchair, where it's converted to optical data and bounced by fiber- optic cable to a computer [1].

The computer

The computer translates brain activity using the custom decoding software. It creates a communication output.

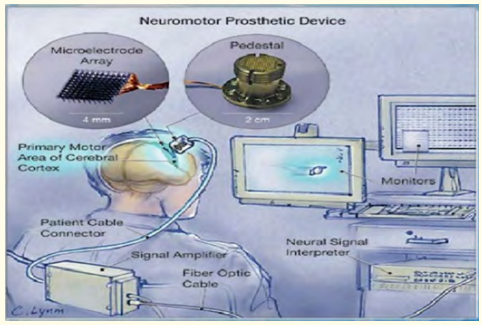

Figure 3: Picture of components of the Brain gate.

Chip Implementation in Brain

Two surgeries are done, one to implant the Brain gate and other is to remove it. Various precautionary measures are taken before the surgery to prevent infections; patients need to bath daily using antimicrobial soap and consume antibiotics, additionally MRI scans are done in order to find the exact place for the sensor in the brain. In aseptic condition and under general anesthesia, the surgeon drills a small hole in the skull and implants the sensor. Patients will receive post-operative care, which also includes a CT scan, blood tests, and care of wound in the hospital for 1 to 5 days postoperatively. After the implantation, one of the doctor's visit the patients at least once a week for about six weeks, then monthly and afterwards as required.

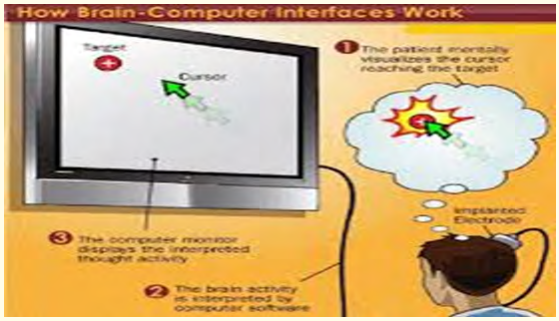

Figure 4: Picture shows Brain computer interfaces work.

Chip working sequence

The sensor having a contact lens' size that is implanted in motor cortex of brain; it controls the movements of hand and arm. A small wire connects the neuro chip to a pedestal that is attached to the skull. The brain's 100 bn neurons pass between 20 and 200 times / second. The electrical signals are sensed by the implanted sensor in the brain and passes to the computer through the cable. These signals are translated to communication output by the computer; this enables an individual by simply using his thoughts to move a cursor on a computer screen.

Software used in BrainGate

It uses algorithm and pattern matching techniques to facilitate communication. The algorithm is written in C+, JAVA, and MATLAB. Signal processing software algorithms examine the electrical activity of neurons and interpret it into control signals for use in various computer-based applications [7].

Brain gate advantages

- Control remote devices
- telephone calls
- Accessing the internet
- switch on or off the lights (7)
- Control robotic arms
- Watch and control television
- Use the pc
- Doors locking or unlocking

Brain gate disadvantages

- Costly
- High risk surgery
- Not been wireless yet
- Difficulty in understanding and learning
- The newest technology is 20bits per minute.

Research related to Brain gate

The clinical trial of Brain Gate was done from 2004 to 2006 by researchers at General Hospital Massachusetts, Brown University,

and the Department of Veterans Affairs. It included the study of 4 tetraplegic patients. The results were published as article within the journal Nature in the year 2006; it explained that just by using the thoughts a person with tetraplegia was able to move a cursor on a computer screen, making him to read emails, and to control gadgets such as a TV.

Dubbed "BrainGate2" a second clinical trial was started in the year July 2009 at Brown University, Massachusetts General hospital, and the Providence VA. In November 2011 researchers from the Stanford University Neural Prosthetics Translational Laboratory joined this trial as a second site and the trial is ongoing.

On 7th November 2009, Toyota launched its wheel chair that works on thought. It has 123 milliseconds response time. Brain Gate researchers published a study in journal Nature in May 2012, demonstrating that two people paralyzed several years earlier by brain-stem stroke were able to operate robotic arms for reaching and grasping. Researchers at Brown University, the Department of Veterans Affairs, Massachusetts General Hospital, Harvard Medical School, and the German Aerospace Center were included in this study included.

Conclusion

The invention of brain gate is such a revolution in medical field. It offers great hope that people who are paralyzed will one day be able to operate artificial limbs, computers or wheel chair independently.

References

1. Sandra VA and Devika Ramgopal. "Brain Gate Technology". International Journal of Engineering Research and Technology 3.28 (2015): 1-4.
2. Levine SP., et al. "A direct brain interface based on event-related potentials". IEEE Transactions on Rehabilitation Engineering 8.2 (2000): 180-185.
3. Wessberg J., et al. "Real-time prediction of hand trajectory by ensembles of cortical neurons in primates". Nature 408.6810 (2000): 361-365.
4. Leigh R Hochberg., et al. "Neuronal ensemble control of prosthetic devices by a human with tetraplegia". Nature 442.7099 (2006): 164-171.
5. M Parameswari T Sasilatha and K Mahalakshmi P. "Real time Brain computer interface system. International Journal of recent technology and engineering". 7.5S2 (2019): 231-233.
6. Bhavani VR., et al. Braingate technology. International Journal of engineering research and technology 3.12 (2015): 1-3.
7. Sharanbasappa Sali and Swapna Ganure. "A Study on Brain Gate Technology for Bio Medical Applications". International Journal of innovative Research in Computer and Communication Engineering 5.4 (2017): 399-403.
8. Taylor DM., et al. "Direct cortical control of 3D neuroprosthetic devices". Science 296.5574 (2002): 1829-1832.
9. Stanley GB., et al. "Reconstruction of natural scenes from ensemble responses in the lateral geniculate nucleus". Journal of Neuroscience 19.18 (1999): 8036-8042.
10. Vidal JJ. "Towards direct brain-computer communication". Annual review of biophysics and bioengineering (1973): 157-180.

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